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The phytosociology of the woody vegetation in the southern part of the Vredefort Dome Area. Part II: Communities of the hills

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The communities that occur in the hills in the Vredefort area were classified by TWINSPAN numerical analysis and further refined by the Braun-Blanquet method. The analysis resulted in the identification of four tree communities. Two communities are subdivided into two subcommunities and the other two into three subcommunities. The differences in species composition between the communities and subcommunities can be related to differences in geology, aspect, stoniness of the soil surface, soil depth, soil texture and slope. The tree communities that cover the hills are the *Protea caffra–Senecio venosus*, the *Buddleja saligna–Rhoicissus tridentata*, the *Combretum molle* and the *Olea europaea* subsp. *africana–Pavetta zeyheri* communities.

Die boomgemeenskappe wat op die bergagtige dele van die Vredefort-area voorkom, is deur middel van TWINSPAN-numeriese-analise geklassifiseer en verder verfyn deur die Braun-Blanquet-metode. Die klassifikasie het tot die identifisering van vier gemeenskappe gelei. Twee gemeenskappe is in twee subgemeenskappe elk onderverdeel en die ander twee in drie subgemeenskappe elk. Die verskille in spesiesamestelling tussen die gemeenskappe en subgemeenskappe kan aan verskille in die geologie, aspek, klipperigheid van die grondoppervlak, gronddiepte, grondtekstuur en helling toegeskryf word. Die boomgemeenskappe wat in die bergagtige dele voorkom, is die *Protea caffra–Senecio venosus*, die *Buddleja saligna–Rhoicissus tridentata*, die *Combretum molle*– en die *Olea europaea* subsp *africana–Pavetta zeyheri*-gemeenskappe.

Keywords: Braun-Blanquet method, classification, tree communities, TWINSPAN

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Introduction

The first part of the account of the woody vegetation of the Vredefort Dome Area dealt with the phytosociology of the tree communities of the plains, riverbanks and island of the Vaal River (du Preez & Venter 1990). This, the second and final part, deals with the phytosociology of the tree communities of the hills.

The hills and valleys found in the study area represent numerous topographic aspects, each contributing to a potentially different habitat type (Bredenkamp & Theron 1978). The complex geology is also an important contributing factor to a rich diversity of habitat types.

The study area, geology, topography and climate were described in Part I of this account (du Preez & Venter 1990).

Methods

The methods applied are those of du Preez & Venter (1990). The percentage in brackets next to each species name represents the constancy of that species.

Results

The communities of the hills are restricted to the rugged quartzite ridges and shales in the valleys of the Hospital Hill Subgroup, the Dominion Reef and the outcrops of the Vredefort Granite. The vegetation is woodland with dense bush in the sheltered ravines. The soils are shallow and a high percentage of surface rocks and stones are present.

Four communities each with two or three subcommunities were distinguished:

1. The *Protea caffra–Senecio venosus* community
1.1 The *Protea caffra–Rhus magalismontana* subcommunity
1.2 The *Protea caffra–Urelytrum agropyroides* subcommunity
2. The *Buddleja saligna–Rhoicissus tridentata* community
2.1 The *Nuxia congesta–Buddleja salviifolia* subcommunity
2.2 The *Buddleja saligna–Rhus undulata* subcommunity
2.3 The *Buddleja saligna–Combretum molle* subcommunity
3. The *Combretum molle* community
3.1 The *Combretum molle–Dombeya rotundifolia* subcommunity
3.2 The *Combretum molle–Grewia flava* subcommunity
3.3 The *Combretum molle–Olea europaea* subcommunity
4. The *Olea europaea–Pavetta zeyheri* community
4.1 The *Olea europaea–Kalanchoe rotundifolia* subcommunity
4.2 The *Olea europaea–Lantana rugosa* subcommunity

1. The *Protea caffra–Senecio venosus* community

This open savanna community, restricted to the eastern and south-eastern slopes (occasionally on the western and northern slopes), of the quartzite ridges and shale slopes, is dominated by *Protea caffra*. A shallow soil occurs among the quartzite rocks. Up to 90% of the surface is covered by stones and rocks (Table 2).

Two subcommunities are identified:

Table 1 Phytosociological table for the woody communities of the hills in the Vredefort area

RELEVE NUMBER	8999999898 8607215937	1 1 99090 94081	7778 8460	87765 13212	5555 3071	343334 890761	886676 249877	5111311 8456187	111 221 109	11422220040 29421304339
COMMUNITY	1		2			3			4	
SUBCOMMUNITY	1,1	1,2	2,1	2,2	2,3	3,1	3,2	3,3	4,1	4,2
SPECIES GROUP 1										
PROTEA CAFFRA	2332322332	22222								
SENECIO VENOSUS	++++++++++	+++++								
HELICHRYSUM NUDIFOLIUM	++++++++++	++++								
BRACHIARIA SERRATA	+++++++ +	+++++								
TAPINANTHUS RUBROMARGINATUS	+RR+ RRR	+R++								
INDIGOFERA SETIFLORA	+++++ ++	+ +++								
CHAETACANTHUS COSTATUS	+ +++ ++	+++++								
ERAGROSTIS CAPENSIS	R++ R+++	+ +++								
PEARSONIA SESSILIFOLIA	+ ++++++	+++ +								
HELICHRYSUM KRAUSSII	+1++ +1	1+++								
LIMEUM VISCOSUM	++ + + ++	++								
TEPHROSIA LONGIPES	+ + ++++	R+ ++								
CONYZA PODOCEPHALA	+ +++ ++	++ +								
ACROTOME HISPIDA	+ + + ++	+ +++								
LOUDETIA SIMPLEX	+++ +	+++ R								
VERNONIA OLIGOCEPHALA	+ + + R	+ ++								
SENECIO AFFINIS	+ + +	+ ++R								
VERNONIA NATALENSIS	+ + + +	+ + +								
CLEOME RUBELLA	+ + R+	R								
SCILLA NERVOSA	+ + +	R R								
ASCLEPIAS BURCHELLII	+ R R	R R								
SONCHUS DREGEANUS	++ +	R +								
HYPOXIS ROOPERI	+ R+	R +								
COMMELINA ECKLONIANA	+ R +	+								
XYSMALOBIUM PARVIFLORUM	R+R R									
BOOPHANE DISTICHA	RR R	R								
VERNONIA STAEHELINOIDES	+ +	++								
SPECIES GROUP 2										
RHUS MAGALISMONTANA	++++++12+									
CYPERUS OBTUSIFLORUS	R +++ ++	+					+			+ R
HYPOXIS RIGIDULA	+ +R++ R	+ +								
SUTERA CAERULEA	R + ++ ++	+								
SENECIO CORONATUS	+ + + R+	+								
ELEPHANTORRHIZA ELEPHANTINA	++ +++ +									
HERMANNIA LANCIFOLIA	+ +++ +	+								
DICOMA ANOMALA	R + R R+	+								
SCHIZOGLOSSUM GLABRESCENS	++ + R +	+								
LEONOTIS OCYMIFOLIA	+ R+ +R	+								
HAEMANTHUS HUMILIS	+ +R++									
DIANTHUS MOOIENSIS	+ R +									
SPECIES GROUP 3										
URELYTRUM AGROPYROIDES	R + R	++++								
TRIRAPHIS ANDROPOGONOIDES	++	+1 +								
SPECIES GROUP 4										
BUDDLEJA SALIGNA			R11	+1233	3+1+	+				
RHOICISSUS TRIDENTATA			+R++	+++++	++++	R				
SPECIES GROUP 5										
NUXIA CONGESTA			1R12							
BUDDLEJA SALVIIFOLIA			++++							
SPECIES GROUP 6										
COMBRETUM MOLLE					1221	+21122	R++111	2++1111		
SPECIES GROUP 7										
GREWIA FLAVA				++			11++++	+	+ +	
PLUMBAGO AURICULATA							R1			

Table 1 Continued

RELEVE NUMBER	8999999898 8607215937	1 1 99090 94081	7778 8460	87765 13212	5555 3071	343334 890761	886676 249877	5111311 8456187	111 221 109	11422220040 29421304339
COMMUNITY	1		2			3			4	
SUBCOMMUNITY	1,1	1,2	2,1	2,2	2,3	3,1	3,2	3,3	4,1	4,2
SPECIES GROUP 8										
OLEA EUROPAEA								R++++	555	R1R1113+++R
PAVETTA ZEYHERI						+	+ ++	+++++++	RR+	R+++++++++R
MAYTENUS HETEROPHYLLA			R+				R	R +R	R	R + R++++
OLDENLANDIA HERBACEA			+					R +++		+R+ R
RHUS RIGIDA			+ R					+R R	+	R+
HYPARRHENIA HIRTA					+			+ R		+R+ R
SPECIES GROUP 9										
COLEOCHLOA SETIFERA								111 +		1
SPECIES GROUP 10										
HELINUS INTEGRIFOLIUS									+R	
DIPCADI VIRIDE									+++	+ ++
KALANCHOE ROTUNDIFOLIA				+					+++	
SPECIES GROUP 11										
ZINNIA PERUVIANA			+	+					1+	++++++ +
FELICIA MURICATA				+	+++					R + R+++
SCHKUHRIA PINNATA				+			+	+		RR+++++ +
LANTANA RUGOSA					R+		+			R+++++
GOMPHRENA CELOSIOIDES					R					+ +++ +
OXALIS CORNICULATA				+					R	R +R
SETARIA SPHACELATA										+++++
PROTASPARAGUS LARICINUS										++++ R
PROTASPARAGUS AFRICANUS				+					+	+ +R
SPOROBOLUS DISCOSPORUS										++ +
CYANOTIS SPECIOSA						+	+			+ ++++
SPECIES GROUP 12										
ZANTHOXYLUM CAPENSE			+++	+++ +	R+R+	R+R +	++R ++	+++++++	++	++++++++++
RHUS UNDULATA			++1+	111R	R R	1 +R	R +	R++RR++	++	1+++1+1R +
DOMBEYA ROTUNDIFOLIA			2	++ ++	+2+	111112	+R ++1	+ +R+		1 +++ +R+ +
PAPPEA CAPENSIS			R	R ++	R+1+	R +	33 +	RR R+ +	R+	++R++++R+++
GREWIA OCCIDENTALIS			+	+ 11	11++	+ +	+	1R + R+	+1+	+++++++ +
EHRETIA RIGIDA				+1 +	++2	+	++++ +	++R+	+++	R+++++ RR
TAPIPHYLLUM PARVIFOLIUM			+	+ R		R 1++R	++ +1	+1111+1		R 1++ 1+
SETARIA LINDENBERGIANA			1++	++	+++	+1121	+ 2	+1111	+	1 + +
PUPALIA LAPPACEA			+R++	+1	1+++	+ +1+	1+	+	+	++++ + +
SIDA DREGEI			+ R	+	+++	R	+	+ +	+ +	++++++++++
DIOSPYROS LYCIOIDES			2+22	1	+	+ +	R	+++++++		++ ++++1
SOLANUM COCCINEUM			++R	R	+ +	R	+ ++	R +++	+ +	R+ +RR
EUCLEA CRISPA			+	+1RR	++++		R+	++R+ +	+++	+ ++ R+
VANGUERIA INFAUSTA			+R+		+		+ ++	RR +RR		R+++R+ +
SCOLOPIA ZEYHERI			+ R	1	++++		+R +R	+R		R+ +
STACHYS HYSSOPOIDES			+ +	+++	+		+ +	+ +		+ + + +
CUSSONIA PANICULATA				+ 11	1 R+			+	+	R R
MYRSINE AFRICANA			1 2		+			+ +		+ +
CELTIS AFRICANA			R2+	+		R	+R	++R	+++	RRR ++++ +
ABUTILON SONNERATIANUM			+	+ +	+++	+R ++	+	+ +	+	+++ + ++
PROTASPARAGUS SUAVEOLENS			R +	+ R	+ +	R	++	+	++	++R+ ++ R
ACHYRANTHES ASPERA			+++	R+		+ R	++	++1	+++	R +1 +
BIDENS PILOSA			+		+	+	++	++++++	+++	+ +
ARISTIDA CONGESTA				++	+++	+		+ R R		+ + +R+
EUSTACHYS PASPALOIDES			+	R	R+++	R	+ +1	+		+ + + +
HIBISCUS CALYPHYLLUS				1	+	+	2 R	++R ++		+ +
TEUCRIUM TRIFIDUM				+		R +	+R	R		+
ERAGROSTIS CHLOROMELAS					+ +	+	++			++
PAVONIA BURCHELLII				+		+				+ R
SOLANUM SUPINUM						R	+			+

Table 1 Continued

RELEVE NUMBER	8999999898 8607215937	1 1 99090 94081	7778 8460	87765 13212	5555 3071	343334 890761	886676 249877	5111311 8456187	111 221 109	11422220040 29421304339
COMMUNITY	1		2			3			4	
SUBCOMMUNITY	1,1	1,2	2,1	2,2	2,3	3,1	3,2	3,3	4,1	4,2
SPECIES GROUP 13										
RHYNCHELYTRUM NERVIGLUME	++ + +++ R	+++		R	+++		++++	+++++++	+	++++++++++
TAGETES MINUTA	+ + +	+ ++	+		+ +		+ R	+ +++ +	+	+++++++++ +
ELIONURUS MUTICUS	2 3+++1++	+ 31			1 +		++	+ +		+1+++
CLEMATIS BRACHIATA	+ + +R +	R +					+	+++	R	++++++++ +R
THEMEDA TRIANDRA	++1++11+++	2 +			++		+++	+	+	+ + +
CRABBIA ACAULIS	R+ ++++ ++	+++						+R	+ +	+++ R R
PHYLLANTHUS PARVULUS	+++ +	+		R	+		R	R+	+ +	++R ++R +
BARLERIA OBTUSA	+ + +++ +	+ +					+	+	R	R ++ R + +
HETEROPOGON CONTORTUS	R+ + + R	+R					++ +			+ +++
ALOE GREATHEADII	+ +	++		+			+ +		+ +	+ +
SPECIES GROUP 14										
ZIZIPHUS MUCRONATA	+R+ ++RR+	+++	2+R	++ +	RR++	+	+R+R++	+ + +	+++	+ +R1 ++ +
RHUS LEPTODICTYA	+RR+ ++	R+R	++R1	+11++	1 ++	+1RRR+	++1+++	1R R2R	+++	++1R ++ ++
PELLAEA CALOMELANOS	+++ + +++	+++ +	+++	++	+++	R +	++ +++	R+++++	+++	++++++++ ++
ERAGROSTIS CURVULA	4+++3+ 14	2+1	+++	+	++	+ 1	++	+RR+1+		++++++++ ++
COMMELINA AFRICANA	+ + ++ +	++ +	+	R	+++	R	++ R	+R ++	+ +	R+R++++++ +
CHEILANTHES HIRTA	+ + +	R +	+R +	++R	R R	+	+ +	+++ +	+++	+ +++++ ++
ACACIA CAFFRA	+1 ++ +	+	1R +	+1 R	+	+ +	+ 1111	+	+++	+ R +
BULBOSTYLIS BURCHELLII	+++++ +++	++	+	+		+		+++ +++		+ + + +
SOLANUM SODOMAEODES	+ + RR		++++	+ R+	++	R		+ ++	+	+RRR R R

1.1 The *Protea caffra–Rhus magalismontana* subcommunity

1.2 The *Protea caffra–Urelytrum agropyroides* subcommunity.

1.1 The *Protea caffra–Rhus magalismontana* subcommunity

A subcommunity restricted to the summit of the quartzite ridges. The soil surface is 90% covered by rocks. The sandy soil is shallower than 0.1 m and has a pH of 4.8 (Table 2).

The tree layer has an average canopy cover and height of 21.8% and 3.1 m respectively (Table 3). *Protea caffra* (100%), *Ziziphus mucronata* (77.8%), *Acacia caffra* (55.6%) and *Rhus leptodictya* (55.6%) are the most prominent tree species (Table 1).

The average canopy cover of the shrub layer is 10% and the average height is 1.5 m (Table 3). This layer is not well developed and the only species present are *Protea caffra* (100%), *Helichrysum kraussii* (66.7%) and *Acacia caffra* (55.6%) (Table 1).

The well-developed herb layer has an average canopy cover of 63.3% and height of 0.4 m (Table 3). The woody dwarf shrubs, *Rhus magalismontana* (100%) and *Elephantorrhiza elephantina* (55.6%) are conspicuous. Species which are constantly present include *Senecio venosus* (100%), *Helichrysum nudifolium* (100%), *Brachiaria serrata* (77.8%), *Indigofera setiflora* (77.8%), *Chaetacanthus costatus* (66.7%), *Eragrostis capensis* (66.7%), *Pearsonia sessilifolia* (66.7%) and *Tephrosia longipas* (66.7%) (Table 1).

1.2 The *Protea caffra–Urelytrum agropyroides* subcommunity

In contrast to the previous subcommunity this subcommunity occurs on the shale slopes adjacent to the quartzite ridges. This subcommunity is differentiated by species group 3. The average soil depth is 0.2 m and the pH is 4.9. The sandy loam soil is 50% covered by stones (Table 2).

The subcommunity is identified by the absence of species group 2.

The tree layer is clearer than subcommunity 1.1 and has an average canopy cover of 35.8% and an average height of 2.8 m (Table 3). The tree species are similar to the *Protea caffra–Rhus magalismontana* subcommunity (Table 1).

The shrub layer has an average canopy cover of 40% and the height is 1.7 m (Table 3). *Protea caffra* (100%) and *Helichrysum kraussii* (66.7%) are also present (Table 1).

The well-developed herb layer has an average canopy cover of 60.8% and an average height of 0.4 m (Table 3). Two grass species, *Urelytrum agropyroides* (66.7%) and *Triraphis andropogonoides* (50%) occur mainly in this subcommunity (species group 3) (Table 1).

2. The *Buddleja saligna–Rhoicissus tridentata* community

The community occurs on the cool very steep south-eastern slopes of the quartzite and epidiorite ridges. The soil texture is a sandy clay loam or may be a clay loam in places (Table 2).

The tree, *Buddleja saligna* (92%) and the liana, *Rhoicissus tridentata* (100%) are characteristic for this community

Table 2 Habitat data of the tree communities of the hills

Community	Aspect	Slope (°)	Parent material	Soil texture	Stoniness of soil (%)	Average soil depth (m)	Average soil pH
1.1	SE, E, S	8.7	Quartzite	Sandy	90	0.1	4.8
1.2	SE, S, SW	15	Shale	Sandy loam	50	0.2	4.9
2.1	S, SW, W	29.0	Quartzite	Sandy clay loam	20	0.2	5.2
2.2	SE, E	17.8	Quartzite	Loam	20	0.35	5.4
2.3	N, E	13.0	Epidiorite	Sandy clay loam	60	0.3	5.7
3.1	N, NE, E	21	Granite	Sandy loam	90	0.2	4.9
3.2	N, NWE	19	Quartzite	Sandy loam	85	0.2	4.3
3.3	N, NE, E	15	Granite	Sandy loam	75	0.2	4.3
4.1	W, N, E	21	Dominion Reef	Sandy loam	10	0.2	6.6
4.2	N, NE, E, S	12	Granite	Sandy loam	80	0.25	5.2

(species group 4), which is divided into three subcommunities (Table 1):

2.1 The *Nuxia congesta–Buddleja salviifolia* subcommunity

2.2 The *Buddleja saligna–Rhus undulata* subcommunity

2.3 The *Buddleja saligna–Combretum molle* subcommunity

2.1 The *Nuxia congesta–Buddleja salviifolia* subcommunity

Species group 5 is diagnostic for this subcommunity. The habitat is rocky humid ravines in the quarzite ridges (Table 2). The black sandy clay loam-textured soil has an average depth of 0.2 m and a pH of 5.2 (Table 2).

The prominent species in the tree layer are *Buddleja salviifolia* (100%), *Diospyros lycioides* (100%), *Nuxia congesta* (100%), *Rhus leptodictya* (100%), *Rhus undulata* (100%), *Acacia caffra* (75%), *Celtis africana* (75%), *Vangueria infausta* (75%), *Zanthoxylum capense* (75%) and *Ziziphus mucronata* (75%) (Table 1). The average canopy cover is 22% and the average height 6.5 m (Table 3).

Buddleja salviifolia and *Nuxia congesta* are both Afromontane species which occur in a cool habitat with a relatively high moisture content. The subcommunity is restricted to drainage lanes.

The shrub layer is well developed with an average canopy cover of 34% and an average height of 1.8 m (Table 3). Species occurring in this layer are *Myrsine africana* (50%), *Rhus rigida* (50%) and saplings of the tree layer species (Table 1).

The average canopy cover of the herb layer is 18.6% and the average height is 0.4 m (Table 3). *Pupalia lappacea* (100%), *Solanum sodomaeodes* (100%), *Achyranthes aspera* (75%), *Eragrostis curvula* (75%), *Pellaea calomelanos* (75%), *Setaria lindenbergiana* (75%) and *Solanum coccineum* (75%) are the prominent herb species (Table 1).

Table 3 Canopy cover and height of the tree communities of the hills

	Stratum					
	Tree		Shrub		Herb	
Community	Average Height (m)	Average Canopy cover (%)	Average Height (m)	Average Canopy cover (%)	Average Height (m)	Average Canopy cover
1.1	3.1	21.8	1.5	10.0	0.4	63.3
1.2	2.8	35.8	1.7	40.0	0.4	60.8
2.1	6.5	22.0	1.8	34.0	0.4	18.6
2.2	4.2	11.3	1.7	35.9	0.3	11.0
2.3	5.9	15.0	1.8	33.8	0.4	13.8
3.1	5.2	31.7	1.6	23.3	0.3	27.4
3.2	4.4	15.0	1.9	25.0	0.5	17.0
3.3	5.6	20.0	1.8	21.4	0.4	13.6
4.1	5.3	75.0	1.8	22.5	0.3	18.5
4.2	5.4	28.2	1.7	21.4	0.4	16.8

2.2 The *Buddleja saligna–Rhus undulata* subcommunity

This subcommunity is identified by the presence of species group 4, the absence of species group 5 and 6 and the relatively high cover values of *Rhus undulata* (100%). The shale slopes (17.8°) to which the subcommunity is restricted have an eastern and south-eastern aspect (Table 2).

The dark reddish-brown soil is 0.35 m deep with a pH of 5.4. Twenty percent of the soil surface is covered with stones (Table 2).

The tree layer has an average canopy cover of 11.3% and an average height of 4.2 m (Table 3). *Buddleja saligna* (100%), *Rhus leptodictya* (100%), *Rhus undulata* (100%), *Dombeya rotundifolia* (80%), *Euclea crispa* (80%), *Zanthoxylum capense* (80%), *Acacia caffra* (60%), *Grewia occidentalis* (60%) and *Ziziphus mucronata* (60%) are the conspicuous species.

Cussonia paniculata (60%) and *Ehretia rigida* (40%) are

the prominent shrub species in the shrub layer (Table 1) that has an average canopy of 35% and an average height of 1.7 m (Table 3).

The average canopy cover and average height of the herb layer are 11% and 0.3 m respectively (Table 3). The layer is weakly developed.

2.3 The *Buddleja saligna–Combretum molle* subcommunity

In contrast with the previous two subcommunities this subcommunity is restricted to the eastern and northern slopes of an epidiorite ridge north west of Vredefort. The texture is mainly a sandy, clay, loam soil with an average depth of 0.3m and a pH of 5.7. The inclination of the slope is 13° (Table 2).

This subcommunity is transitional between the *Buddleja saligna–Rhoicissus tridentata* community and the *Combretum molle* community. The simultaneous presence of species groups 4 and 6 is diagnostic (Table 1).

A poorly developed tree layer is dominated by *Buddleja saligna* (100%), *Combretum molle* (100%), *Euclea crispa* (100%), *Grewia occidentalis* (100%), *Pappea capensis* (100%), *Scolopia zeyheri* (100%), *Zanthoxylum capense* (100%), *Ziziphus mucronata* (100%), *Brachylaena rotundata* (75%), *Cussonia paniculata* (75%), *Dombeya rotundifolia* (75%) and *Rhus leptodictya* (75%) (Table 1). Despite the large number of species present the average canopy cover is only 15% and the average height 5.9 m (Table 3).

The average canopy cover and average height of the shrub layer are 33.8% and 1.8 m respectively (Table 3). *Ehretia rigida* (75%) and some of the tree species are represented (Table 1).

The average canopy cover of the herb layer is 13.8% and the average height is 0.4 m (Table 3). Prominent grass species are *Eustachys paspaloides* (100%), *Setaria verticillata* (100%), *Aristida congesta* (75%) and *Setaria lindenbergiana* (75%). The herbs are *Pupalia lappacea* (100%), *Abutilon sonneratianum* (75%), *Commelina africana* (75%), *Felicia muricata* (75%), *Pellaea calomelanos* (75%) and *Sida dregei* (75%) (Table 1).

3. The *Combretum molle* community

Two subcommunities of this community occur on outcrops of the Vredefort granite while the other two are found on the quartzites of the Hospital Hill Subgroup. The *Combretum molle* community mainly inhabits the northern and south-eastern slopes of the ridges. *Combretum molle* is the only species differentiating this community.

As mentioned this community can be divided into three subcommunities, namely:

3.1 The *Combretum molle–Dombeya rotundifolia* subcommunity
3.2 The *Combretum molle–Grewia flava* subcommunity
3.3 The *Combretum molle–Olea europaea* subcommunity

3.1 The *Combretum molle–Dombeya rotundifolia* subcommunity

This subcommunity is restricted to the Vredefort granite outcrops. The slopes of outcrops are distinctly steeper (21°) than those on which the *Combretum molle–Olea europaea* subcommunity (15°) is found. The slopes are extremely stoney and also covered with huge granite boulders. The percentage stone that covers the soil is 90% (Table 2).

The soil texture is sandy loam with an average depth of 0.2 m and a pH of 4.9 (Table 2).

The prominent tree species are *Combretum molle* (100%), *Dombeya rotundifolia* (100%), *Rhus leptodictya* (100%), *Zanthoxylum capense* (66.7%) and *Rhus undulata* (50%) (Table 1). The average canopy cover is 31.7% and the average height is 5.2 m (Table 3).

The shrub layer is also weakly developed. *Tapiphyllum parvifolium* (83.3%) and *Ehretia rigida* (16.7%) are the shrub species present (Table 1). The average canopy cover is 23.3% and the average height 1.6 m (Table 3).

The herb stratum has an average canopy cover of 27.4% and an average height of 0.3 m (Table 3). The species with the highest constancy are *Abutilon sonneratianum* (66.7%) and *Pupalia lappacea* (66.7%). *Setaria lindenbergiana* (83.8%) is the only dominant grass (Table 1).

3.2 The *Combretum molle–Grewia flava* subcommunity

This subcommunity occurs on the warm dry northern and north-western slopes of the quartzite ridges where the average slope is 19° (Table 2).

The sandy loam soil has an average depth of 0.2 m and an average pH of 4.2. A high percentage stone (85%) covers the soil surface (Table 2).

This subcommunity is differentiated by species group 7. The absence of *Olea europaea* in species group 8 and the relatively high cover values of *Acacia caffra* (group 14) is characteristic (Table 1).

The tree layer is dominated by *Acacia caffra* (100%), *Combretum molle* (100%), *Rhus leptodictya* (100%), *Ziziphus mucronata* (100%), *Dombeya rotundifolia* (75%), *Vangueria infausta* (75%) and *Zanthoxylum capense* (75%) (Table 1). The average canopy cover is 15% and the average height is 4.4 m (Table 3).

The average canopy cover of the shrub layer is 25% and the average height 1.9 m (Table 3). The shrub species present are *Grewia flava* (100%), *Ehretia rigida* (75%), *Pavetta zeyheri* (75%) and *Tapiphyllum parvifolium* (75%) (Table 1).

The herbaceous layer has an average canopy cover of 17% and the average height to 0.5 m (Table 3). The grass species present are *Rhynchelytrum nerviglume* (100%), *Eustachys paspaloides* (75%) and *Themeda triandra* (75%). *Setaria lindenbergiana* is absent and other herbs are sparsely dispersed and of low constancy (Table 1).

3.3 The *Combretum molle–Olea europaea* subcommunity

The habitat of this subcommunity differs from the previous two as it is restricted to outcrops of Vredefort granite. The aspects vary from north and north-east to east. The average slope is 15° (Table 2).

The sandy loam soil has an average depth of 0.2 m and a very acidic pH of 4.3. Seventy five per cent of the soil surface is covered by rocks and boulders (Table 2).

Combretum molle (100%), *Rhus undulata* (100%) and *Zanthoxylum capense* (100%) have the highest constancy. They are accompanied by *Euclea crispa* (71.4%), *Grewia*

occidentalis (71.4%), *Olea europaea* (71.4%), *Pappea capensis* (71.4%), *Rhus leptodictya* (71.4%), *Vangueria infausta* (71.4%) and *Dombeya rotundifolia* (57.1%). *Acacia caffra* (14,3%) is very poorly represented. *Olea europaea* is diagnostic for this subcommunity since it is restricted to the Vredefort granite outcrops and the Dominion Reef (Table 1). The average canopy cover is 20% and the average height 5.6 m (Table 3).

The shrub layer has an average canopy cover of 21.4% and an average height of 1.8 m. This layer is also well developed with *Diospyros lycioides* (100%), *Pavetta zeyheri* (100%), *Tapiphyllum parvifolium* (100%) and *Ehretia rigida* (57.1%) as the dominant species (Table 1).

The herb stratum is characterized by *Setaria lindenbergiana* (71.4%) with a relative high cover value of between 10% and 20%. The other prominent grasses are *Rhynchelytrum nerviglume* (100%), *Eragrostis curvula* (85.7%) and *Cynodon dactylon* (71.4%). *Coleochloa setifera* (57.1%), a sedge, is also prominent and characterizes this subcommunity (species group 9). The herbs with a high constancy are the xerophytic fern *Pellaea calomelanos* (100%), *Bidens pilosa* (85.7%), *Bulbostylus burchellii* 85.7% (71.4%), *Hibiscus calyphyllus* (71.4%) and *Tagetes minuta* (71.4%) (Table 1). The average canopy cover is 13.6% and the average height 0.4 m (Table 3).

4. The *Olea europaea–Pavetta zeyheri* community

This community occurs on the Vredefort granite outcrops except for one subcommunity which inhabits the Dominion Reef.

The community is differentiated by *Olea europaea* and *Pavetta zeyheri* of species group 8 (Table 1). The two subcommunities are:

4.1 *Olea europaea–Kalanchoe rotundifolia* subcommunity
4.2 *Olea europaea–Lantana rugosa* subcommunity

4.1 The *Olea europaea–Kalanchoe rotundifolia* subcommunity

This subcommunity is restricted to the Dominion Reef bordering a quartzite ridge of the Hospital Hill Subgroup where it covers the western, southern and eastern slopes. The slopes are relatively steep, with an average of 12° (Table 2). The species of species group 10 characterize this subcommunity (Table 1).

The sandy loam soil has an average depth of 0.2 m and a pH of 6.6 (Table 2).

The tree layer forms a closed canopy. *Olea europaea* (100%) is dominant. *Acacia caffra* (100%), *Celtis africana* (100%), *Euclea crispa* (100%), *Grewia occidentalis* (100%), *Rhus leptodictya* (100%), *Ziziphus mucronata* (100%), *Pappea capensis* (66.7%), *Rhus undulata* (66.7%) and *Zanthoxylum capense* (66.7%) are the tree species present (Table 1). The average canopy cover is 75% and the average height 5.3 m (Table 3).

The average canopy cover of the shrub layer amounts to 22.5% and the average height to 1.8 m (Table 3). The prominent species are *Ehretia rigida* (100%), *Olea europaea* (100%), *Pavetta zeyheri* (100%), *Grewia flava* (66,7%) and *Helinus integrifolius* (100%), (Table 1).

The herb stratum is weakly developed, due to the dense canopy layer. The average canopy cover of the herb layer is 18.5% and the average height 0.3 m (Table 3). *Achyranthes aspera* (100%), *Bidens pilosa* (100%), *Cheilanthes hirta* (100%), *Dipcadi viride* (100%) and *Kalachoe rotundifolia* (100%) are the prominent species (Table 1). The last two herbs characterize the subcommunity further (Table 1).

4.2 The *Olea europaea–Lantana rugosa* subcommunity

This subcommunity is restricted to the Vredefort granite outcrops south and north-west of Vredefort where the slopes average 12°. The subcommunity occurs on the northern, north-eastern, eastern and southern aspects.

The average soil depth is 0.25 m and the average pH is 5.2 (Table 2).

The tree layer's average canopy cover is 28.2% and the average height is 5.4 m (Table 3). The prominent trees are *Olea europaea* (100%), *Pappea capensis* (100%), *Rhus undulata* (81.8%), *Dombeya rotundifolia* (72.7%), *Grewia occidentalis* (72.7%), *Rhus leptodictya* (72.7%), *Diospyros lycioides* (63.6%), *Maytenus heterophylla* (63.6%) and *Ziziphus mucronata* (63.6%) (Table 1).

The average canopy cover of the shrub layer is 21.0% and the average height is 1.7 m (Table 3). The dominant shrub species are *Ehretia rigida* (72.7%) and *Tapiphyllum parvifolium* (54.5%) (Table 1).

The subcommunity is characterized by the herb species in species group 11 (Table 1). The most prominent species are *Schkuhria pinnata* (72.7%), *Zinnia peruviana* (63.6%) *Felicia muricata* (54.5%), *Lantana rugosa* (54.5%), *Cyanotis speciosa* (45.5%), *Gomphrena celosioides* (45.5%), *Protasparagus laricinus* (45.5%) and *Setaria sphacelata* (45.5%) (Table 1).

The herb layer is well developed and the average canopy cover is 16.8% while the average height is 0.4 m (Table 3). The prominent herb species are mainly pioneer species that indicate disturbance by cattle and sheep. The dominant species are *Sida dregei* (100%), *Commelina africana* (90.9%), *Pellaea calomelanos* (90.9%), *Tagetes minuta* (90.9%), *Phyllanthus parvulum* (81.8%), *Protasparagus suaveolens* (18.8%), *Cheilanthes hirta* (72.7%), *Abutilon sonneratianum* (54.5%), *Barleria obtusa* (54.5%), *Pupalia lappacea* (54.5%) and *Solanum sodomaeodes* (54.5%) (Table 1).

Conclusion

The vegetation was classified into units which are separable on the basis of presence and absence of groups of associated species related to specific environmental factors (Bredenkamp & Theron 1980). A strong correlation exists between vegetation differences and certain habitat factors. The vegetation differences are usually related to differences in aspect, rockiness of the soil and geology. Factors like soil depth, soil texture, pH and slope are also important.

The vegetation of the hills was classified into four communities namely the *Protea caffra–Senecio venosus* community, the *Buddleja saligna–Rhoicissus tridentata* community, the *Combretum molle* community and the *Olea europaea–Pavetta zeyheri* community. All these communities and their subcommunities are the product of interaction

between the vegetation and different environmental conditions. These results further show, as also noted by Bezuidenhout *et al.* (1988), that certain species may be indicators of the presence of specific geological formations.

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